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REMARKS

Claims 1-27 and 31-43 stand variously rejected in the outstanding Official Action. Claims 2, 21, 22 and 35 have been amended and newly written claims 44-58 offered for consideration. Accordingly, claims 1-27 and 31-58 remain in the application.

Applicants submit herewith two signed Declarations: one under Rule 131 swearing behind the Rohr et al and Ekins-Daukes II references and one under Rule 132 comprising testimony of an expert, Dr. Neal Anderson.

Rule 131 Declaration Swearing Behind Rohr (and Ekins-Daukes II)

The Rule 131 Declaration is of a number of co-inventors swearing behind the Rohr et al reference (which is earlier than the Ekins-Daukes II reference and thus it is "sworn behind" as well). The Declaration also confirms that, at the time of the invention the co-inventor authors of the Rohr reference had an obligation to assign that invention to the same assignee as the present application. Therefore, while the co-authors of the Rohr et al reference are not identical to the inventors listed in the present application, nevertheless the invention disclosed was made by the above-disclosed inventors and that at the time of invention the inventors had an obligation to assign to the Imperial College as noted in the Assignment recorded January 16, 2002, at Reel 12491, Frame 144 of record in this application.

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Thus, applicants have both "sworn behind" and sworn under 35 USC §103(c) to remove both the Rohr and the Ekins-Daukes II references from any rejection of applicants' pending claims.

Rule 132 Expert Declaration of Dr. Neal Anderson

Applicants enclose the Declaration under Rule 132 of Dr. Neil G. Anderson, an expert in the field of quantum semiconductor heterostructures and their application in photovoltaic cells, lasers, and blue/UV optoelectronics. Dr. Anderson's Declaration is particularly pertinent to the Examiner's various rejections based upon allegations that applicants' specification is either not enabling to one of ordinary skill in the art or does not provide a proper basis for the pending claims. A detailed discussion of each of the Examiner's bases for objection or rejection of the claims based upon the two attached Declarations follows.

On page 2, section 2 of the Official Action, the Examiner suggests that his previous rejection of claims 10-13 and 27 under the first paragraph of §112 remains and provides his supporting rationale. The Examiner makes four points which have been specifically responded to by applicants' independent outside expert, Dr. Neil Anderson, in his Rule 132 Declaration attached hereto. These four allegations set out by the Examiner are set forth in Dr. Anderson's Declaration at paragraphs 3(a)-(d).

It is noted that in view of Dr. Anderson's *curriculum vitae* attached to the Declaration and his statements that as an assistant professor since 1988 he has taught

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undergraduate and graduate engineering students (paragraph 4), he can effectively opine as to the level of skill of those persons of ordinary skill involved in the photovoltaic cell art. Additionally, in paragraph 5 of the Anderson Declaration, Dr. Anderson states that with the present specification teaching

"how to grow a multi-quantum well system according to the stress balance condition on InP substrates and InAsP or InGaAs 'virtual' substrates, it would be straightforward for a person of ordinary skill in this art to apply these teachings to other Group III-V ternary or quaternary systems on GaSb and GaAs substrates."

For the detailed support of this position, Dr. Anderson points out in paragraph 6 of his Declaration the support in applicants' specification which specifically traverses each of the Examiner's four conclusions with regard to the rejection of §112.

Specifically, paragraph 6(a) of Dr. Anderson's Declaration points to the portion of the specification which describes how to produce a stressed balanced multiple quantum well device on a InP substrate and that the substitution of quaternary compounds would be an obvious variant to one of ordinary skill in the art in view of the present disclosure.

In paragraph 6(b), Dr. Anderson points out that as described in the referenced portion of applicants' specification, the conditions to be met to produce a device according to the claimed invention is explicitly described for any suitable material system, and one of ordinary skill in the art would be clearly enabled to use the material in a quantum well portion as set out in the claims.

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In paragraph 6(c), Dr. Anderson also points to a similar portion of the specification which clearly enables one of ordinary skill in the art to use GaSb or GaAs as substrates and obtain the benefit of the present invention.

Finally at paragraph 6(d), Dr. Anderson, in reference to a similar portion of the specification, concludes that this disclosure is more than sufficient so as to enable one of ordinary skill in the art to use the claimed material in making the claimed device.

Thus, the substance of each of the statements 6(a) through 6(d) establish that the Examiner has no basis for his allegation of a rejection of claims 10-13 and 27 under 35 USC §112 (first paragraph) as set out in section 2, page 2, of the Final Rejection. Accordingly, this rejection is again traversed.

The Examiner's statement in section 3 of the Final Rejection that the previous rejection of a number of claims under the second paragraph of §112 as being indefinite has been withdrawn is appreciated. Similarly, the Examiner's statement in section 4 on page 3 of the Final Rejection that the rejection of claims 2 and 35 under §112 (second paragraph) has been overcome by applicants' previous amendment is also appreciated.

In section 5 of the Final Rejection, the rejections of claims 4, 5, 21 and 22 under 35 USC §112 (second paragraph) is indicated as not being overcome. As noted above, applicants' have offered an amendment to claims 21 and 22 making each of them directly dependent on claim 20 which provides clear antecedent basis for the references to "said

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tensile strained layers" and "said compressively strained layers." Therefore, the objection to claims 21 and 22 has been overcome.

The previous rejection of claims 4 and 5 (as set out in the Official Action mailed August 2, 2002, Paper No. 4) is found on page 4 of the previous Action, with the Examiner concluding that "since this material is not defined, it could arbitrarily be chosen from any material having a lattice constant equal to the lattice constant of the substrate." This statement comprises an admission by the Examiner that the claim language is definite, in that the lattice constant interrelationships are clearly and effectively specified.

However, the Examiner's conclusion that no particular material is defined and thus the claim is quite broad does not support his conclusion that the claim language is indefinite. Federal Circuit cases have clearly held that broad claims are not indefinite and it is further noted that the subject matter of claims 4 and 5 depend from claim 3 which ultimately includes the limitations of claim 1, i.e. the limitations in claims 4 and 5 must be taken into consideration as further limitations of the photovoltaic device specified in applicants' claim 1. Those of ordinary skill in the art will clearly understand that there are materials which cannot be used to provide a photovoltaic device having quantum wells in a plurality of barriers and thus those materials would not fall within the subject matter of applicants' claims 4 and 5. However, the Examiner's admission that "the quantum well would necessarily have a different composition than the material used in the claimed structure" i.e. that the claimed subject matter is defined, although broad, must

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also be tempered by the fact that these claims ultimately depend from claim 1, and therefore only structures compatible with claim 1 would be obvious to those of ordinary skill in the art to use.

As a result, there is no basis supporting the Examiner's rejection of claims 4 and 5 and the amendments to claims 21 and 22 obviate any further rejection thereto.

In section 6 on page 3 of the Final Rejection, the Examiner states that the application of Rohr et al ("Strain-Balanced $In_{0.62}Ga_{0.38}As/In_{0.47}Ga_{0.53}As$ (InP) Quantum Well Cell For Thermophotovoltaics" (hereinafter Rohr)) and Ekins-Daukes et al ("Strained and Strain-Balanced Quantum Well Devices For High-Efficiency Tandem Solar Cells" (hereinafter Ekins-Daukes II)) is still valid under 35 USC §102.

The Rohr reference was not presented until September 21, 2000, and thus its publication is less than one year prior to applicants' priority date of July 25, 2001. The attached Declaration under Rule 131 (of inventors Rohr, Connolly and Barnham) establishes that the publication is in fact a disclosure of the invention set forth and claimed in the present application. The Declaration confirms that the co-inventors had the present invention prior to the publication date of the Rohr reference and, as support, attaches a draft copy of the Rohr reference that describes their invention. Thus, having "sworn behind" the Rohr reference, it is no longer available under 35 USC §102.

Additionally, as set out in section 6 of the Rule 131 Declaration, at the time the invention was made, the co-inventors of the present application, as well as the co-

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inventors listed in the Rohr reference, were subject to an obligation to assign the rights in the invention to the Imperial College of Science, Technology and Medicine in London, England, i.e. under §103(c) Rohr cannot be used as a reference.

Therefore, under either Rule 131 or §103(c), Rohr is not available as prior art. The Ekins-Daukes II reference was published in April 2001, well after the Rohr reference, and in view of the Rule 131 Declaration establishing that the co-inventors invented the claimed invention prior to September 21, 2000, they have effectively sworn behind Ekins-Daukes II as well. As a result, neither Rohr nor Ekins-Daukes II is available as a reference against the claims in the present application.

In paragraph 8 beginning on page 3 of the Final Rejection, the Examiner rejects claims 10-13 and 27 under 35 USC §112 (first paragraph) as not providing enablement for other materials as substrates or "strontium-containing layers." Dr. Anderson, in commenting upon these new allegations of the Examiner, points out that the Examiner effectively admits the enablement of the present application in his statement "the application is 'enabling for using InP substrates and InGaAsP or AlGaAs quantum well layers and barrier layers.'" In paragraphs 7(a)-(e), Dr. Anderson addresses a number of unsupported statements made by the Examiner in paragraph 8 of the Final Rejection.

In paragraph 9 of Dr. Anderson's Declaration, he directly responds to each of these statements made by the Examiner pointing out how they do not cast any doubt on the enablement of the presently claimed invention. Perhaps of most interest is the fact that

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Sb is antimony and not strontium as alleged by the Examiner on page 4, line 2 ("or strontium-containing layers"). Moreover, Dr. Anderson discusses the specific example device on page 6, line 20 to page 7, line 24, as well as the explicit disclosure of how the technique may be applied to other suitable material systems.

As a result of these discussions, Dr. Anderson concludes that with respect to a) the specification clearly provides an enabling disclosure for other materials as substrates and antimony-containing layers, b) the specification is sufficiently detailed to enable one of ordinary skill in the art to practice the invention, c) the specification provides an enabling disclosure for the use of materials other than InP, d) the specification contains a sufficient disclosure such that those of ordinary skill in the art will appreciate that materials other than InGaAsP could be used for the quantum well and barrier layers; and e) that as admitted by the Examiner, the "dark current behavior" is shown, but that in view of the specification, one of ordinary skill in the art could easily construct the cell that produced the behavior in Figure 6.

The Examiner is reminded that in order to be enabling, it is not necessary that applicant's specification teach a person having no skill in the art. Rather, the statutory requirement is that the specification be sufficiently detailed so as to permit one of "ordinary skill in the art" to practice the invention without "undue experimentation." As set out in paragraph 4 of Dr. Anderson's Declaration, one of ordinary skill in the photovoltaic cell art would have an undergraduate degree in electrical or electronics

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engineering, would have at least a masters degree in a related electrical engineering field and at least five years experience in the photovoltaic cell field. Thus, the person having ordinary skill in the photovoltaic cell art would be a highly skilled and experienced individual. Thus, Dr. Anderson's conclusion that the present application's disclosure with a specific example plus the explicit disclosure of how the technique may be applied to other suitable material systems is more than sufficient to enable one of ordinary skill in the art to practice the claimed invention.

In section 10 of the Final Rejection, the Examiner rejects claims 2, 4, 5, 7-9, 21, 22, 24 and 35 under 35 USC §112 (second paragraph) as being indefinite.

The Examiner's objection to claims 2 and 35 is well taken and applicants enclose herewith proposed amendments deleting the "wherein" clause in each of these claims, thereby obviating any further rejection thereof. The objection to claims 4, 5, 21 and 22 appears to be a duplicate of the rejection mentioned at section 5, page 3 of the Final Rejection and has previously been responded to. The Examiner's statement that the same basis of rejection also applies to dependent claims 7-9 and 24 is also believed to be responded to by the above discussion.

The rejection of claims 21 and 22 as having insufficient antecedent basis appears to be a duplicate of the rejection of claims 21 and 22 in section 5 on page 3 of the Official Action and has previously been responded to by the above amendment.

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Claims 1-6, 12, 13, 42 and 43 stand rejected under 35 USC §102(b) as being anticipated by Ekins-Daukes I. As noted in the previous Amendment (page 10, second paragraph), Ekins-Daukes I teaches the desirability of having "compositions such that a period of one tensile strained layer and one compressively strained layer exerts substantially no shear force on a neighboring structure" but does not teach a method of achieving this desired result. As set forth in Dr. Anderson's Declaration at paragraphs 10 and 11, confirm what will be readily apparent by reading the Ekins-Daukes I reference, i.e. that while it teaches that the average lattice constant of the wells and barriers "should" be the same, it does not teach a method for creating layers in which each individual period exerts substantially no shear force on a neighboring structure as required by the claims.

As stated in paragraph 12 of the Rule 132 Declaration, Dr. Anderson testifies that the methods taught in Ekins-Daukes I are "insufficiently exact to ensure periods which exert 'substantially no shear force on a neighboring structure'." Thus, while Ekins-Daukes I does teach the desirability, it has been found to not contain sufficient teaching of how to achieve the strain balance of applicants' claimed invention. It is noted that Ekins-Daukes II, while suggesting such strain balance, is not available as a reference, as it is sworn behind by the date of invention set forth in the Rule 132 Declaration. Consequently, there is no basis for a future rejection of claims 1-6, 12, 13, 42 and 43 under 35 USC §102 as anticipated by Ekins-Daukes I.

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In section 13 of the Official Action, claims 1-5, 7, 16 and 17 stand rejected under 35 USC §102 as being anticipated by Rohr. The attached Declaration under Rule 131 removes Rohr reference, either because applicants invented the claimed invention prior to the Rohr publication and/or because there was a mutual obligation for the authors which comprise inventors of the invention disclosed in Rohr and the present co-inventors to assign the rights to the same assignee, i.e. the Imperial College of Science, Technology and Medicine.

In section 14 of the Final rejection, claims 1-6 and 12-14 stand rejected under 35 USC §102 as anticipated by Ekins-Daukes ("Strained and Strain-Balanced Quantum Well Devices For High-Efficiency Tandem Solar Cells" (hereinafter Ekins-Daukes II)). Inasmuch as applicants' Rule 131 Declaration establishes a date of invention well before Ekins-Daukes II's April 2001 publication date, it is predicated as a reference and cannot be the basis of any further rejection in this application.

In section 16 of the Official Action, claims 7-11, 14 and 15 stand rejected under 35 USC §103 as being unpatentable over Ekins-Daukes I in view of Freundlich (U.S. Patent 5,851,310; hereinafter Freundlich I).

Claims 7-11, 14 and 15 all ultimately depend from applicants' independent claim 1, and as established above, the Ekins-Daukes I reference does not disclose or render obvious the portion of claim 1 which recites that the layers have "compositions such that a period of one tensile strained layer and one compressively strained layer exerts

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substantially no shear force on a neighboring structure" teaching. In the discussion of the Freundlich reference, the Examiner does not indicate how or where it teaches this disclosure which is missing from the Ekins-Daukes I reference. As a result, neither Ekins-Daukes I nor Freundlich teaches this operational interrelationship between structures recited in applicant's independent claim 1 and therefore the combination of these two structures would not teach or render obvious applicants' claim 1 invention. Accordingly, any further rejection of claims 7-11, 14 and 15 is respectfully traversed.

Claims 16 and 17 stand rejected under 35 USC §103 as unpatentable over Ekins-Daukes I in view of Freundlich (U.S. Patent 6,150,604; hereinafter Freundlich II). Again, claims 16 and 17 depend directly from applicants' claim 1 and therefore the above feature distinguishing claim 1 from the Ekins-Daukes I reference are herein incorporated by reference.

A review of paragraph 17 of the Final Rejection does not provide any indication that the Freundlich II (USP 6,150,604) reference provides the disclosure missing from the Ekins-Daukes reference. Accordingly, if both prior art references fail to disclose a claimed feature of applicants' claims, even if they were combined, they could not render obvious applicants' combination. Here the Examiner has not pointed out where or how this feature is taught in the prior art references, nor has he provided any basis for combining the references. Accordingly, any further rejection of claims 16 and 17 under 35 USC §103 is respectfully traversed.

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Claims 18, 21-23 and 25-27 stand rejected under 35 USC §103 as unpatentable over Freundlich I. Independent claim 18 specifies a photovoltaic device having multiple well quantum portions formed on a virtual substrate having a virtual substrate lattice constant different from a substrate lattice constant of an underlying substrate and identifies the virtual substrate as $\text{InP}_{1-x}\text{As}_x$, where zero is less than x is less than one, and said substrate is InP.

The Examiner has failed to point out where Freundlich I teaches the specific virtual substrate as recited in applicants' claim 18. A review of column 3, lines 58-62, cited by the Examiner, does not contain all of the limitations of applicants' claim 18 and therefore does not anticipate or render obvious the subject matter of claim 18 or claims 21-23 and 25-27 ultimately dependent from claim 18.

In section 19 of the Final Rejection, the Examiner rejects claims 19, 20 and 24 as obvious in view of Freundlich I in view of Ekins-Daukes I. As noted above, Freundlich I does not contain all of the limitations set out in applicants' independent claim 18. The Examiner has not identified where Ekins-Daukes I discloses the missing specifications of the claimed "virtual substrate." Therefore, even the combination of Freundlich I and Ekins-Daukes I cannot render obvious the subject matter of claim 18 or claims 19, 20 and 24 ultimately dependent thereon.

Claims 31-33 and 36-41 stand rejected as obvious over Freundlich I in view of Freundlich II as discussed in section 20 of the Final Rejection. Claims 31-33 and 36-41

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ultimately depend from claim 18 and the above comments distinguishing claim 18 from the Freundlich I reference are herein incorporated by reference. Additionally, the Examiner has not pointed out how Freundlich II discloses the claimed aspects.

Claims 31-33 and 36-41 all ultimately depend from claim 18 and therefore the above comments distinguishing claim 18 over the Freundlich I reference are herein incorporated by reference. The Examiner has failed to note any disclosure in Freundlich II which supplies the missing interrelationship of the claimed "virtual substrate" and therefore neither reference teaches the subject matter of claim 18, let alone the subject matter of claim 18 as limited by claims 31-33 and 36-41.

In section 21 of the Final Rejection, the Examiner rejects claims 34 and 35 as unpatentable over Freundlich I in view of Freundlich II as previously applied to claims 31-33 and 36-41, and further in view of Ekins-Daukes I. The above comments regarding the Freundlich I/Freundlich II combination are herein incorporated by reference. Additionally, there is no allegation by the Examiner that Ekins-Daukes I supplies the missing claim feature of claim 18 from which claims 34 and 35 ultimately depend. Therefore, we have the situation in which none of the three cited references teach one claimed feature of applicants' independent claim 18. Moreover, Ekins-Daukes, as noted in Dr. Anderson's Declaration, in teaching average strain balancing, would lead those of ordinary skill in the art away from applicants' claimed individual period strain balancing.

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As a result, one of ordinary skill in the art would not think to combine these three references and still arrive at applicants' claimed invention.

Entry of the Amendment Under Rule 116

It is respectfully requested that the above amendments to claims 2, 21, 22 and 35 and newly written claims 44-58 be entered. The amendments to claims 21 and 22 merely correct the dependency so as to provide antecedent basis for the structures referred to in those claims. As this structural interrelationship was previously searched by the Examiner and is the subject of existing multiple rejections, this change in dependency overcoming the alleged lack of antecedent basis will not necessitate further search or consideration of these claims, but will remove the basis for rejection under §112 from the Board of Appeals.

The amendments to claims 2 and 35 respond to a rejection of these claims on a basis raised for the first time in the Final Rejection. It is noted that these claims were amended prior to the Final Rejection in response to a lack of antecedent basis rejection in the first Official Action.

With respect to both the rejections of claims 21 and 22 and claims 2 and 35, the above amendments correct minor informalities with the claims. The elimination of these informality rejections will permit the Board, if necessary, to focus on the rejections of the claims on the merits and applicants' attached Declarations responding thereto.

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Additionally, entry of newly written claims 44-58 is requested as these claims limit the subject matter of the previous independent claims to the specific formulations set forth in claim 44. Consideration of these newly written claims is requested. Accordingly, prosecution in this application will be advanced and the Examiner is respectfully requested to make the above amendments for the purposes of appeal in this application.

Consideration of the attached Declarations is believed appropriate and applicants understand that the Examiner may well decide to allow all pending claims in view of these Declarations.

Applicants believe that all bases for rejection set out in the Final Rejection have been responded to and that claims 1-27 and 31-58 are in condition for allowance and notice to that effect is respectfully solicited. In the event the Examiner is of the opinion that a brief telephone or personal interview will facilitate allowance of these claims, he is respectfully requested to contact applicants' undersigned representative.

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Respectfully submitted,

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Enclosures:

Rule 131 Declaration Swearing Behind
Rohr...
Rule 132 Declaration, Dr. Anderson

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CERTIFICATION OF FACSIMILE TRANSMISSION

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